# Notice No.1

## Rules for the Manufacture, Testing and Certification of Materials, July 2021

The status of this Rule set is amended as shown and is now to be read in conjunction with this and prior Notices. Any corrigenda included in the Notice are effective immediately.

Please note that corrigenda amends to paragraphs, Tables and Figures are not shown in their entirety.

## Issue date: November 2021

| Amendments to | Effective date | IACS/IMO implementation (if applicable) |
|---|---|---|
| Chapter 1, Sections 4 & 6 | 1 January 2022 | N/A |
| Chapter 3, Sections 6 & 11 | 1 January 2022 | N/A |
| Chapter 4, Section 1 | 1 January 2022 | N/A |
| Chapter 5, Section 1 | 1 January 2022 | N/A |
| Chapter 10, Sections 6 & 7 | 1 January 2022 | N/A |
| Chapter 11, Section 10 | 1 January 2022 | N/A |
| Chapter 12, Section 5 | 1 January 2022 | 1 January 2022 |
| Chapter 12, Section 7 | 1 January 2022 | N/A |
| Chapter 13, Section 10 | 1 January 2022 | N/A |
| Chapter 14, Section 3 | 1 January 2022 | N/A |
| Chapter 15, Section 2 | 1 January 2022 | N/A |

Lloyd's Register

# Chapter 1
# General Requirements

## ■ *Section 4*
## General requirements for manufacture

### 4.3 Heat treatment

4.3.2 Heat treatment is to be carried out in properly constructed furnaces which are efficiently maintained and have adequate means for control and recording of temperature. The furnace dimensions are to be such as to allow the whole item to be uniformly heated to the necessary temperature. In the case of very large components which require heat treatment, alternative methods will be specially considered. Furnace temperature uniformity surveys to recognised standards (e.g. ASTM A991) shall be carried out at the specified frequency.

## ■ *Section 6*
## References

### 6.1 General

**Table 1.6.1 List of National and International Standards (partly shown)**

| Rule Reference | Standard |
|---|---|
| Chapter 1 General Requirements | ASTM A991 |
| Chapter 3 – Rolled Steel Plates, Strip, Sections and Bars | ASTM E45<br>EN 10164 |
| Chapter 4 – Steel Castings | ISO 1161<br>ASTM A991 |
| Chapter 5 – Steel Forgings | ASTM E112<br>ASTM A991 |

# Chapter 3
# Rolled Steel Plates, Strip, Sections and Bars

## ■ *Section 6*
## Carbon–manganese and nickel alloy steels for low temperature service

### 6.4 Mechanical tests

6.4.1 For plates, one tensile test specimen~~s~~ ~~are~~ is to be taken from ~~both~~ one end~~s~~ of each piece. A piece is to be regarded as the rolled product from a single slab or from a single ingot if this is rolled directly into plates.

## ■ *Section 11*
## High strength steel for special marine applications

### 11.1 Goal-based framework

*(Part only shown)*

11.1.6 The list of performance requirements (PR) is as follows:

(a) The material shall have the mechanical properties, for Material Class (Special Application), as specified in *Table 3.11.1 Essential mechanical properties for Material Class ~~(~~Special Application~~s~~) 1 and 2*, and any other project requirements.

(b) The material shall have the chemical composition~~,~~ for the appropriate Material Class (Special Application 1 or 2), as specified in *Table 3.11.2, Chemical composition for Material Class ~~(Special Applications)~~ 1 and 2*, and any other project requirements.

(f) The weldability of the material shall be confirmed by either an evidence-based regime according to a recognised method, or by a performance-based regime, agreed with LR:

(i) The maximum carbon equivalent value (CEV), when calculated using UK Defence Standards criteria, shall be ~~0,64 (for thickness 6–30 mm) and 0,70 (for thickness 30.1–150 mm)~~ as specified in *Table 3.11.3, Carbon equivalent values for Material Class Special Applications 1 and 2*.

(ii) The maximum CEV values, when calculated using LR Rules, shall be as per the values of H55QT or H69QT (for Material Class Special Applications 1 and 2 respectively), within *Table 3.10.3 Maximum Ceq, CET and Pcm values*.

(g) A typical tensile strength value will be in the range of 640-820 N/mm$^2$, for Material Class Special Application 1.

(h) A typical tensile strength value will be in the range of 725-860 N/mm$^2$, for Material Class Special Application 2.

*Existing Table 3.11.1 has been deleted and replaced with below;*

**Table 3.11.1 Essential mechanical properties for Material Class Special Applications 1 and 2**

| Material Class (Special Application) (*see* Note 1) | Yield strength (or 0,2% proof strength) (minimum) N/mm$^2$ | Elongation (minimum) % | Charpy value J (minimum) | Charpy test temperature °C | Hardness value (HB) |
|---|---|---|---|---|---|
| High Strength Steel – Special Application 1 | 550 | 20 | 80 | −80 | 207 - 248 |
| High Strength Steel – Special Application 2 | 690 | 18 | 80<br><br>For thickness > 60 mm<br><br>70 | −80<br><br>−80 | 228 - 270 |

Note 1. In addition to the above performance requirements for essential mechanical properties (for Material Class Special Applications 1 and 2), the following tables provide further details for tensile, hardness, and Charpy impact requirements, should the LR accepted solution route be followed.

- *Table 3.11.11 Tensile and hardness properties for High Strength Steel for Material Class Special Applications 1 and 2*
- *Table 3.11.12 Charpy impact properties for High Strength Steel for Material Class Special Applications 1 and 2*

*Existing Table 3.11.2 has been deleted and replaced with below;*

**Table 3.11.2 Chemical composition for Material Class Special Applications 1 and 2**

| Material grade chemical composition | Material Class (Special Application) | | |
|---|---|---|---|
| | High Strength Steel – Special Application 1 | High Strength Steel – Special Application 2 | |
| | Element (%) by weight | | |
| | All thickness ranges (*see* Note 1) | Plate Thickness (mm) | |
| | | 6 to 32 inclusive (*see* Note 5) | Over 32 to 76 (*see* Note 5) | Over 76 to 140 (*see* Note 5) |
| Carbon | ≤0,18 | 0,10 – 0,18 | 0,14 – 0,20 | 0,14 – 0,20 |
| Manganese | 0,10–0,40 | 0,10 – 0,40 | 0,10 – 0,40 | 0,10 – 0,40 |
| Aluminium (*see* Note 2) | 0,015–0,060 | 0,015 – 0,060 | 0,015 – 0,060 | 0,015 – 0,060 |
| Phosphorus (*see* Note 3) | ≤0,015 | 0,015 | 0,015 | 0,015 |
| Sulphur | ≤0,008 | 0,004 | 0,004 | 0,004 |
| Silicon | 0,15–0,35 | 0,15 – 0,38 | 0,15 – 0,38 | 0,15 – 0,38 |
| Nickel | 2,25–3,25 | 2,25 – 3,50 | 2,75 – 3,50 | 3,00 – 3,50 |

| | | | | |
|---|---|---|---|---|
| Chromium | 1,00–1,80 | 1,00 – 1,80 | 1,40 – 1,80 | 1,50 – 1,90 |
| Molybdenum | 0,2–0,6 | 0,20 – 0,60 | 0,35 – 0,60 | 0,50 – 0,65 |
| Nitrogen (*see* Note 2) | ≤0,012 | 0,010 | 0,010 | 0,010 |
| Residual elements | | | | |
| Titanium | ≤0,020 | 0,02 | 0,02 | 0,02 |
| Vanadium | ≤0,020 | 0,03 | 0,03 | 0,03 |
| Copper | ≤0,20 | 0,25 | 0,25 | 0,25 |
| Arsenic | ≤0,03 | 0,025 | 0,025 | 0,025 |
| Antimony | ≤0,010 | 0,025 | 0,025 | 0,025 |
| Lead | ≤0,005 | Not specified | Not specified | Not specified |
| Tin | ≤0,02 | 0,030 | 0,030 | 0,030 |
| Cobalt (*see* Note 4) | ≤0,03 | 0,030 | 0,030 | 0,030 |

Note 1. The listed product percentage by weight values also apply to ladle percentage weight values, with the exception of sulphur, where the maximum percentage weight value is ≤0,006.

Note 2. The steel is to be fully killed, using aluminium fine grain practice, with a minimum aluminium content of 0,015 per cent and greater than twice the percentage nitrogen.

Note 3. Where plates are specified as subject to stress relief, the preferred maximum phosphorus content is 0,010 per cent and is not to exceed 0,012 per cent.

Note 4. For Naval submersible craft with nuclear propulsion, and where the project authority requires, each cast is to be analysed for cobalt. Where the content exceeds 0,030 per cent, instructions are to be obtained from the project authority before release of the product. For commercial submersible craft, there is no requirement for cobalt content analysis.

Note 5. Single values are maximum percentages. These elements should not be added deliberately.

### 11.2 LR accepted solutions for high strength steel for special marine applications

11.2.5 The requirements presented herein represent an accepted material solution to meet the requirements of High Strength Steel – Special Application 1 and Special Application 2, of which Q1(N) and HY100 (UK) grades of rolled plate ~~is an~~ are respective ~~example~~ examples.

### 11.3 General requirements

11.3.3 Supplied High Strength Steel – Special Application 2 plate product is to be in the thickness range 6,00 mm to 140 mm.

### 11.4 Manufacture and chemical composition

11.4.1 All plate products are to be produced by LR approved steelmaking processes, and any specific requirements for casting type ~~(e.g. ingot casting or continuous casting)~~ shall be specified by the project.

11.4.2 High Strength Steel – Special ~~Application 1~~ Applications has strict chemical composition ranges and limits for feedstock ('ladle') and rolled product. These are indicated in *Table 3.11.2 Chemical composition for Material Class ~~(Special Applications)~~ 1 and 2*. Each cast is to be analysed using ladle samples. For product analysis, test samples are to be taken from mid-thickness at the top centre portion of each plate, as shown in *Figure 3.11.1 Location of test pieces for mechanical testing, chemical analysis and metallography*.

11.4.3 Carbon equivalent is to be calculated using the following formula, and the results compliant with the values listed in *Table 3.11.3 Carbon equivalent values for Material Class Special Applications 1 and 2*:

$$CEV = C + \frac{Mn}{6} + \frac{Ni}{40} + \frac{Cr}{5} + \frac{Mo}{4} + \frac{Si}{24} + \frac{V}{15}$$

**Note**. This CEV formula is only to be used for High Strength Steel – Special Application class steels. Other references to CEV formulae within LR Rules are not applicable to High Strength Steel – Special Application class steels. Similarly, this formula shall not be used to determine CEV for any other steel or product contained in other Rules, Chapters or Sections not related specifically to High Strength Steel – Special Application 1 or Special Application 2 class steel.

*Existing Table 3.11.3 has been deleted and replaced with below;*

**Table 3.11.3 Carbon equivalent values for Material Class Special Applications 1 and 2**

| High Strength Steel – Special Application 1 | | | High Strength Steel – Special Application 2 | |
|---|---|---|---|---|
| Plate thickness (mm) | Carbon equivalent values | | Plate thickness (mm) | Carbon equivalent values |
| | Target | Maximum | | |
| 6 – 30 mm | 0,62 | 0,64 | All thickness ranges | 0,75 max |
| 30,1 – 150 mm | 0,66 | 0,70 | | |

**11.5 Heat treatment**

11.5.1 ~~High Strength Steel – Special Application 1 plates~~ Plates are to be supplied in the quenched and tempered condition~~.~~ with the following specific requirements:

(a) For Special Application 1, ~~The~~ the plates shall be hardened by heating above the upper critical temperature, but not to more than 950°C, followed by water spray quenching. Subsequent quenching shall be in the range 600°C to 675°C. Heat treatment records are to be supplied for each batch. Pickling or flame descaling is not permitted after heat treatment.

(b) For Special Application 2, the manufacturer may determine the detailed procedure to produce plates meeting the mechanical property requirements with the exception that the final tempering temperature is to be in the range 660°C to 680°C. Plates, after receiving tempering and heat treatment, shall be cooled at a rate equal to or faster than air cooling**.**

**11.6 Cleanliness**

11.6.2 Material is to exhibit homogeneous microstructure throughout the section thickness and be free from macro segregation.

**11.7 Dimensions, flatness, thickness and weight control**

11.7.1 Plates are to be supplied to nominal dimensions as required in *Table 3.11.5 Dimensional tolerances for Material Class Special Applications 1 and 2*.

*Existing Table 3.11.5 has been deleted and replaced with below;*

**Table 3.11.5 Dimensional tolerances for Material Class Special Applications 1 and 2**

| **Tolerance on length and width of plate for Special application 1** | | |
|---|---|---|
| **Length of plate** | Tolerance | |
| | Minus | Plus |
| Up to and including 3000 mm | 0 | 13 mm |
| Over 3000 mm up to and including 6000 mm | 0 | 25 mm |
| Over 6000 mm | 0 | 32 mm |
| **Tolerance on length and width of plate for Special application 2** | | |
| **Thickness of plate** | Tolerance | |
| | Minus | Plus |
| Up to and including 51 mm | 6 mm | 19 mm |
| Over 51 mm thick up to and including 102 mm | 6 mm | 25 mm |
| Over 102 mm | 6 mm | 29 mm |

11.7.2 Plates are to comply with the flatness tolerances in *Table 3.11.6 Flatness tolerance for plate and measurement information for Special Application 1 and Table 3.11.7 Flatness tolerance for plate and measurement information for Special Application 2*.

*(Table not shown as no technical amendments have been made)*

**Table 3.11.6 Flatness tolerance for plate and measurement information for Special Application 1**

**Table 3.11.7 Flatness tolerance for plate and measurement information for Special Application 2**

| Thickness (mm) | Flatness Tolerances for specified widths (mm) (*see* Notes 1, 2 and 3) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Up to 900 | 900 to 1,200 | 1,200 to 1,500 | 1,500 to 1,800 | 1,800 to 2,100 | 2,100 to 2,400 | 2,400 to 2,700 | 2,700 to 3,000 | 3,000 to 3,600 | Over 3,600 |
| 6 to 10 | 19 | 24 | 29 | 35 | 44 | 48 | 51 | 57 | 60 | - |
| Over 10 up to 13 | 19 | 22 | 24 | 24 | 29 | 33 | 38 | 41 | 48 | 70 |
| Over 13 up to 19 | 16 | 19 | 22 | 22 | 25 | 29 | 32 | 35 | 41 | 57 |
| Over 19 up to 25 | 16 | 19 | 22 | 22 | 24 | 25 | 29 | 33 | 38 | 51 |
| Over 25 up to 51 | 14 | 16 | 19 | 21 | 22 | 24 | 25 | 25 | 25 | 41 |
| Over 51 up to 102 | 13 | 14 | 18 | 19 | 19 | 19 | 19 | 22 | 25 | 32 |
| Over 102 up to 140 | 14 | 18 | 19 | 19 | 22 | 22 | 24 | 29 | 32 | 32 |
| Measurement | The flatness as specified in the table is to be an overall flatness factor. This factor is not to apply to 'kinks' or 'waviness'. The waviness or kinking permitted is to be evaluated by laying a one metre straight edge across the affected edges. The maximum permissible deviation from the straight edge is 6,5 mm. | | | | | | | | | |
| Note 1. Flatness tolerances for length and width. The longer dimension specified is considered the length and variations from a flat surface along the length are not to exceed the tabular amount for the specified width in any 4,0 metres of length.<br>Note 2. When the longer dimension is under 1 metre, the variation in flatness is not to exceed 6 mm.<br>Note 3. The above table and notes cover the flatness tolerances of circular and sketch plates, based on the maximum dimensions of those plates. | | | | | | | | | | |

11.7.3 All plates ~~should~~ shall be subject to thickness gauging and weight control. Conformance criteria are shown in *Table 3.11.~~7~~8 Tolerances for thickness and weight control for Special Application 1, and Table 3.11.9 Tolerances for thickness and weight control for Special Application 2*.

11.7.4 Thickness gauging may be taken by the use of calibrated mechanical or ultrasonic instruments, with the following grid sections to be applied:

(a) For undressed plates, grid lines are to be marked 25 mm from each edge and end, thereafter at intervals of 600 mm x 600 mm grid squares.

(b) For dressed areas, the grid size is reduced to 150 mm x 150 mm for plates up to and including 12 mm thick, and 300 mm x 300 mm for plates over 12 mm thick.

**Table 3.11.~~7~~8 Tolerances for thickness and weight control for Special Application 1**

| Item | Plate thickness (mm) | Tolerances | | | |
|---|---|---|---|---|---|
| | | Thickness | Maximum weight | | |
| | | | Bulk orders | | Small orders or individual plates |
| | | | Individual plates | Batch | |
| A | 6,1–12 | +2% −7% | +2% | +0 | +2% |
| B | 12,1–25 | +1% −3% | +1% | +0 | +1% |
| C | 25,1 and over | +1% −3% | +1% | +0 | 0 |
| D | Plates for insert pads | +5% -0 | Not applicable | Not applicable | Not applicable |

~~Note 1. Thickness gauging is to be undertaken in accordance with specific project requirements.~~

Note 1 ~~2~~. ~~Plates~~ Where required by the project requirements, plates are to be weighed after final heat treatment with any surface dressing and abrasive blasting completed. The machine accuracy should be ±1,0 per cent of the nominal weight of subject plate.

**Table 3.11.9 Tolerances for thickness and weight control for Special Application 2**

| Item | Nominal Plate Thickness (mm) | Thickness Tolerance |
|---|---|---|
| A | 6 to 25 inclusive | +0,75 mm - 0,25 mm |
| B | Over 25,1 up to and including 75 | +3% - 0,25 mm |
| C | Over 75 | +2,25 mm - 0,25 mm |
| Note 1. Where required by the project requirements, plates are to be weighed after final heat treatment with any necessary dressing of the surface and abrasive blasting completed. The machine accuracy should be ±1,0 per cent of the nominal weight of subject plate. | | |

11.7.5 Weld repairs of plate defects are not permitted for either Special Application 1 or Special Application 2.

### 11.9 Mechanical tests

11.9.1 Sampling: Test specimens are to be taken from each finally heat-treated plate in accordance with *Table 3.11.8 Mechanical test samples*. The locations of test samples for mechanical testing, chemical analysis and metallography are indicated in *Figure 3.11.1 Location of test pieces for mechanical testing, chemical analysis and metallography*. ~~When required, through-thickness tensile requirements (sampling, testing and acceptance criteria) are to be defined by the project requirements.~~

11.9.2 When required for Special Application 1, through thickness tensile requirements (sampling, testing and acceptance criteria) are to be defined by the project requirements which should, as a minimum, conform to EN 10164, and quality class Z35. For Special Application 2 through thickness tensile requirements are to be in accordance with *Table 3.11.10 Mechanical test samples*.

*(Part only shown)*

**Table 3.11.~~8~~10 Mechanical test samples**

| Dimensions | Samples required |
|---|---|
| Plates over 3000 mm in length | Tensile – as per *Figure 3.11.1 Location of test pieces for mechanical testing, chemical analysis and metallography*.<br><br>Charpy – as per *Figure 3.11.1 Location of test pieces for mechanical testing, chemical analysis and metallography*.<br><br>Samples acquired from both plate ends.<br><br>Hardness – test at diagonally opposite corners.<br><br>Through thickness tensile (where required) - as per *Figure 3.11.1 Location of test pieces for mechanical testing, chemical analysis and metallography*. |
| Plates under 3000 mm in length | Tensile – as per *Figure 3.11.1 Location of test pieces for mechanical testing, chemical analysis and metallography*.<br><br>Charpy – as per *Figure 3.11.1 Location of test pieces for mechanical testing, chemical analysis and metallography*.<br><br>Samples acquired from one plate end only.<br><br>Hardness – test at diagonally opposite corners. |

| | |
|---|---|
| | Through thickness tensile (where required) - as per *Figure 3.11.1 Location of test pieces for mechanical testing, chemical analysis and metallography*. |
| Notes: Through thickness tensile | a. For all plate material equal or greater than 30 mm thick, full thickness short transverse tensile tests are to be taken from the first plate of the cast (top end) to assess through thickness ductility (according to EN 10164).<br>b. Samples are to be taken from the positions shown in *Figure 3.11.1 Location of test pieces for mechanical testing, chemical analysis and metallography*. For non-extension pieces these are to be as per EN 10164:<br>The test piece shall have the following diameter, $d_o$:<br>$d_o$ = 6 mm or 10 mm for $20 \le t \le 40$, where $t$ is the plate thickness in mm;<br>$d_o$ = 10 mm for $40 < t \le 400$, where $t$ is the plate thickness in mm.<br>c. The acceptance criteria are to Quality Class Z35, as per EN 10164. |

~~11.9.2~~ 11.9.3 The results of mechanical tests shall comply with the appropriate requirements given in the following tables:

- *Table 3.11.1 Essential mechanical properties for Material Class ~~(~~Special Applications~~)~~ 1 and 2*
- ~~*Table 3.11.9 Mechanical properties for High Strength Steel – Special Application 1 Class steel*~~.
- *Table 3.11.11 Tensile and hardness properties for High Strength Steel for Material Class Special Applications 1 and 2*
- *Table 3.11.12 Charpy impact properties for High Strength Steel for Material Class Special Applications 1 and 2*

*Existing Table 3.11.9 has been deleted and replaced by Tables 3.11.11 and 3.11.12.*

**Table 3.11.11 Tensile and hardness properties for High Strength Steel for Material Class Special Applications 1 and 2**

| **Material Class** | **Thickness** | **0,2% Proof strength (N/mm²)** (*see* Notes 1 and 2) | | **Elongation %** | **Reduction in area %** | **Hardness HB** |
|---|---|---|---|---|---|---|
| | | **Min** | **Max** | **Min** | **Min** | **Range** |
| **Special Application 1** | ≤16 mm | 550 | 690 | 20 | - | 207– 248 |
| | 16,1 mm up to 150 mm | 550 | 655 | 20 | 55 – Longitudinal<br>50 – Transverse | 207–248 |
| **Special Application 2** | <19 mm | 690 | 825 | 18 | - | 228– 270 (Note 3) |
| | 19 mm up to 140 mm | 690 | 825 | 18 | 45 – Transverse | 228–270 (*see* Note 3) |

Note 1. For High Strength Steel Special Application 1, the tensile strength is to be recorded and is to be such that the ratio of 0,2% proof strength to tensile strength for all plate thickness is not to exceed 0,90.

Note 2. For High Strength Steel Special Application 2, the tensile strength is to be recorded and is to be such that the ratio of 0,2% proof strength to tensile strength for plate thickness from 6 mm to less than 19 mm thick is not to exceed 0,95, and for plate thickness 19 mm and above, the ratio is not to exceed 0,92.

Note 3. If any result is outside the range 228 HB to 270 HB, the cause of the discrepancy between hardness and the normally expected tensile strength shall be fully investigated by the steel mill before the plate can be despatched from the steel mill. The project authority and LR shall be notified of the reasons for any discrepancy between the hardness and expected tensile results and any ensuing mitigation actions.

**Table 3.11.12 Charpy impact properties for High Strength Steel for Material Class Special Applications 1 and 2**

| Material Class | Thickness | Charpy value J | Charpy test temperature °C |
|---|---|---|---|
| **Special Application 1** | <12 mm | 80 | (−80) |
| | | 65 for a 7,5 x 10 mm sample | (−80) |
| | | or; | (−80) |
| | | 55 (5 mm x 10 mm sample) | |
| | ≥12 mm (*see* Note 1) | 80 | (−80) |
| **Special Application 2** | <12 mm | 65 for a 7,5 x 10 mm sample, or; 5 mm x 10 mm sample | (−80) |
| | 12 mm up to 60 mm (*see* Note 2) | 55 for a 10 x 10 mm sample | (−80) |
| | >60 mm up to 140 mm (*see* Note 3) | 70 for a 10 x 10 mm sample | (−80) |

Note 1. The energy absorbed by each of the three test pieces (using a 10 x 10 mm sample) is to be greater than 80 Joules

Note 2. The average energy absorption of the three test pieces (using a 10 x 10 mm sample) for thicknesses up to 60 mm inclusive at each end of the plate is to be not less than 80 joules, and no single specimen is to be less than 70 joules.

Note 3. For plates over 60 mm thick the average value is to be not less than 70 joules, and no single value is to be less than 55 joules.

### 11.11 Additional approval testing

11.11.1 The project requirements may specify appropriate and additional specialised testing for manufacturer approval.

### 11.12 Visual and NDE requirements

11.12.2 Surface defects: ~~Afterfinal~~ After final heat treatment and abrasive blasting, e.g. shot blasting, each plate is to be examined visually for surface ~~defects~~ discontinuities. ~~Surface~~ Any surface discontinuities shall be defined as imperfections or defects and ~~will~~ are to comply with project specific acceptance criteria.

11.12.3 Internal defects: Examination for internal defects shall be carried out as required by the project specification and comply with project-specific acceptance criteria. Where project requirements for examination of plates are not specified, LR requires ultrasonic testing to be carried out, and the extent and acceptance criteria shall be agreed with LR.

# Chapter 4
# Steel Castings

## ■ *Section 1*
## General requirements

### 1.5 Heat treatment

1.5.2 Heat treatment is to be carried out in a properly constructed furnace which is efficiently maintained and has adequate means of temperature control. The furnace dimensions are to be such as to allow the steel castings to be uniformly heated to the necessary temperature. Sufficient thermocouples are to be connected to the steel castings to show that their temperature is adequately uniform and the temperatures are to be recorded throughout the heat treatment. ~~Alternative procedures are to be approved by LR, Materials and NDE department.~~ The records are to identify the furnace that was used and give details of the individual steel castings, the heat treatment temperature and time at temperature and the date. The Surveyor is to examine the charts and confirm the details on the certificate. In the case of very large components which require heat treatment, alternative methods will be specially considered.

1.5.3 As an alternative procedure to the connection of thermocouples as required by *Ch 4, 1.5 Heat treatment 1.5.2*, temperature uniformity surveys of the heat treatment furnace may be accepted subject to approval by LR, Materials and NDE department. An initial temperature uniformity survey in the furnace fully loaded condition is required to be carried out in accordance with recognised standards (e.g. ASTM A991). Regular temperature uniformity surveys are then subsequently required at a frequency of at least once per year.

*Existing paragraph 1.5.3 has been renumbered as 1.5.4.*

# Chapter 5
# Steel Forgings

## ■ *Section 1*
## General requirements

### 1.5 Heat treatment

1.5.2 Heat treatment is to be carried out in a properly constructed furnace which is efficiently maintained and has adequate means of temperature control. The furnace dimensions are to be such as to allow all the steel forgings to be uniformly heated to the necessary temperature. In the case of very large forgings, alternative methods of heat treatment will be specially considered. Sufficient thermocouples are to be connected to the steel forging(s) in the furnace to show that the temperature is adequately uniform and the temperatures are to be recorded throughout the heat treatment. Copies of these records are to be presented to the Surveyor together with a sketch showing the positions at which the temperature measurements were carried out. The records are to identify the furnace that was used and give details of the steel-making heat, the heat treatment temperature, time at temperature and the date. The Surveyor is to examine the charts and confirm the details on the certificate. ~~Alternative procedures are to be approved by LR's Materials and NDE Department.~~

1.5.3 As an alternative procedure to the connection of thermocouples as required by *Ch 5, 1.5 Heat treatment 1.5.2*, temperature uniformity surveys of the heat treatment furnace may be accepted subject to approval by LR, Materials and NDE department. An initial temperature uniformity survey in the furnace fully loaded condition is required to be carried out in accordance with recognised standards (e.g. ASTM A991). Regular temperature uniformity surveys are then subsequently required at a frequency of at least once per year.

*Existing paragraph 1.5.3 has been renumbered as 1.5.4.*

### 1.9 Rectification of defects

1.9.3 Repair welding is not permitted for ~~crankshafts or similar rotating components~~ forgings subject to torsional fatigue, such as crankshafts and propeller shafts.

# Chapter 10
# Equipment for Mooring and Anchoring

## ■ *Section 6*
## Steel wire ropes

### 6.7 Certification

6.7.1 ~~Unless otherwise requested by the purchaser, a manufacturer's certificate, in accordance with *Ch 1, 3.1 General 3.1.3. (c)*, is to be issued.~~ Where specified in applicable LR Rules or Codes, an LR certificate or manufacturer's certificate validated by LR, in accordance with *Ch 1, 3.1 General 3.1.3 (a)* or *Ch 1, 3.1 General 3.1.3 (b)* respectively, is to be issued. Otherwise a manufacturer's certificate, in accordance with *Ch 1, 3.1 General 3.1.3 (c)*, is to be issued and in such cases the certificate is to be validated by the manufacturer's authorised representative, independent of the manufacturing department.

## ■ *Section 7*
## Fibre ropes

### 7.4 Certification

7.4.1 ~~A manufacturer's certificate, in accordance with Ch 1, 3.1 General 3.1.3.(c), is to be issued. The certificate is to be validated by the manufacturer's representative, who is to be independent of the production process and LR.~~ Where specified in applicable LR Rules or Codes, an LR certificate or manufacturer's certificate validated by LR, in accordance with *Ch 1, 3.1 General 3.1.3 (a)* or *Ch 1, 3.1 General 3.1.3 (b)* respectively, is to be issued. Otherwise a manufacturer's certificate, in accordance with *Ch 1, 3.1 General 3.1.3 (c)*, is to be issued and in such cases the certificate is to be validated by the manufacturer's authorised representative, independent of the manufacturing department.

# Chapter 11
# Approval of Welding Consumables

## ■ *Section 10*
## Consumables for high strength steel for special marine applications

### 10.1 Goal-based framework

*(Part only shown)*

10.1.6 The list of performance requirements (PR) is as follows:

(a) The mechanical properties of the weld metal shall comply with the consumable grade requirements stated in *Table 11.10.1 Mechanical property requirements for deposited metal tests (manual, semi-automatic and automatic multi-run techniques) for consumable grade and applicable Material Class ~~(Special Applications)~~ 1 and 2*.

(e) The results of butt weld test assemblies are to comply with the requirements given in *Table 11.10.2 Mechanical property requirements for butt weld tests (all techniques) for consumable grade and applicable Material Class ~~(Special Applications)~~ 1 and 2)*.

**Table 11.10.1 Mechanical property requirements for deposited metal tests (manual, semi-automatic and automatic multi-run techniques), for consumable grade and applicable Material Class ~~(Special Applications)~~ 1 and 2**

| Consumable grade | Material Class (Special Application) | Yield strength N/mm$^2$ minimum | Tensile strength N/mm$^2$ | Elongation on 50 mm % minimum | Charpy V-notch impact tests | |
|---|---|---|---|---|---|---|
| | | | | | Test temperature °C | Individual energy value J minimum |
| HSS1 | High Strength Steel – Special Application 1 | 550 | 640–820 | 18 | −50 | 50 |

| | | | | | | |
|---|---|---|---|---|---|---|
| HSS2 (Undermatched) | High Strength Steel – Special Application 2 (Undermatched welds) | 565 | 640-820 | 18 | −50 | 50 |
| HSS2 (Matched) | High Strength Steel – Special Application 2 (Matched welds) | 690 | 770-940 | 17 | −50 | 50 |

**Table 11.10.2 Mechanical property requirements for butt weld tests (all techniques) for consumable grade and applicable material ~~class~~Class ~~(~~Special Applications~~)~~ 1 and 2**

| Consumable ~~Grade~~ grade | Material Class (Special Application) | Tensile strength N/mm$^2$ | Bend test ratio: D/t | Charpy V-notch impact tests | |
|---|---|---|---|---|---|
| | | | | Test temperature °C | Individual energy value J minimum |
| HSS1 | High Strength Steel – Special Application 1 | 640–820 | 5 | -50 | 50 |
| HSS2 (Undermatched) | High Strength Steel – Special Application 2 (Undermatched weld) | 640–820 | 5 | -50 | 50 |
| HSS2 (Matched) | High Strength Steel – Special Application 2 (Matched weld) | 770 - 940 | 5 | -50 | 50 |

## 10.2 LR accepted solutions for welding consumables for high strength steel for special marine applications

10.2.5 The requirements presented herein represent an accepted solution for LR certified welding consumables, for use with High Strength Steel – Special Application 1 and Special Application 2, ~~(high strength steel for special applications class 1)~~ of which Q1(N) and HY100 (UK) grade ~~is an~~ ~~example~~ of rolled plate are respective examples.

## 10.3 General requirements

10.3.4 ~~Dependent on the results of mechanical and other tests, approval~~ Approval will be granted by assigning the grade HSS1~~.~~, HSS2 (Undermatched), or HSS2 (Matched), where the consumable achieves the required properties for each designated grade, based on the project design and application requirements.

10.3.5 Steel plate material for test panels is to be the same as the intended application of material class, i.e. High Strength Steel – Special Application 1, or High Strength Steel – Special Application 2.

10.3.6 Where the relevant Section requires deposited metal assemblies to be made and tested, the results of all tensile and notch impact tests are to comply with the requirements given in *Table 11.10.1 Mechanical property requirements for deposited metal tests (manual, semi-automatic and automatic multi-run techniques) for consumable grade and applicable Material Class ~~(~~Special Applications~~)~~ 1 and 2*.

10.3.9 Where the relevant Section requires butt weld assemblies to be made and tested, the results of transverse tensile, notch impact and bend tests are to comply with the requirements given in *Table 11.10.2 Mechanical property requirements for butt weld tests (all techniques) for consumable grade and applicable Material Class ~~(~~Special Applications~~)~~ 1 and 2*, as appropriate. The position of fracture from the transverse tensile test is to be reported.

## 10.4 Annual tests

10.4.2 The results are to comply with the requirements given in *Table 11.10.1 Mechanical property requirements for deposited metal tests (manual, semi-automatic and automatic multi-run techniques) for consumable grade and applicable Material Class ~~(~~Special Applications~~)~~ 1 and 2* and *Table 11.10.2 Mechanical property requirements for butt weld tests (all techniques) for consumable grade and applicable Material Class ~~(~~Special Applications~~)~~ 1 and 2*, as appropriate.

# Chapter 12
# Welding Qualifications

## ■ *Section 5*
## Welder Qualification Tests

### 5.1 Scope

5.1.6 Welder qualification tests made in accordance with EN, ISO, JIS, ASME or AWS may be considered for acceptance provided that, as a minimum, they are equivalent to, and meet the technical intent of these Rules in terms of qualification examination, testing, and range of approval to the satisfaction of the Surveyor. The extension of validity of welder qualifications shall be in accordance with the requirements of *Ch 12, 5.7 Welders qualification certification*.

### 5.7 Welders qualification certification

5.7.4 The Surveyor shall extend the validity of the approval by one of the following methods:

(a) Re-test the welder every 3 years.

(b) ~~After~~ Every 2 years, two welds made within the previous six months are to be subject to radiographic inspection or ultrasonic inspection or destructively tested and the result recorded. Welding shall reproduce all initial test conditions except for thickness. Subject to satisfactory examination or testing the qualification is revalidated for a further 2 years. The Surveyor will signify acceptance of the extension to the validity by endorsing the certificate.

(c) At intervals not exceeding 3 years, the quality aspects detailed in *Ch 12, 5.7 Welder qualification tests 5.7.5* are to be demonstrated by the manufacturer to the satisfaction of Surveyor. The Surveyor will signify acceptance of the extension of the validity by endorsing the certificate. This method is not permitted for welder qualifications related to welding of pipes and pressure vessels.

5.7.5 Quality aspects:

(a) The welder was qualified by the same manufacturer and is working under their direct control.

(b) The manufacturer is working in accordance with a quality management system specified in *Ch 12, 5.7 Welder qualification tests 5.7.6*.

(c) The manufacturer has documented at least once a year that the welder has produced acceptable weld(s) meeting rule requirements in the welding positions, weld types, welding processes and the backing conditions covered by the welder certificate. Evidence should include NDE or destructive test results of welding.

5.7.6 For the extension of welder's qualification validity permitted by the method detailed in *Ch 12, 5.7 Welder qualification tests 5.7.4 (c)*, the manufacturer should have certification to a recognised quality management system under LR, or under an independent body acceptable to LR, and include the following minimum requirements:

(a) A designated person is responsible for the coordination of the welder quality management system.

(b) A list of all welders, including their qualification status, and welding supervisors in the shipyard/manufacturer is maintained.

(c) A welder qualification certificate is issued to each qualified welder.

(d) Training requirements are specified for the welder qualification programme.

(e) An identification and traceability system is in place for welders and WPS used on production welds.

(f) A procedure is in place to monitor performance of each welder based on the results of weld examination records and the weld repair rates. The procedure should also specify the criteria for the retesting of each welder based on the performance results.

*Existing paragraphs 5.7.5 to 5.7.7 have been renumbered 5.7.7 to 5.7.9.*

## ■ *Section 7*
## Welding qualification requirements for high strength steel for special marine applications

### 7.1 Goal-based framework

*(Part only shown)*

7.1.6 The list of performance requirements (PR) is as follows:

(a) For welding procedure qualification tests, the mechanical properties for category A and B welds shall comply with the requirements stated in *Table 12.7.1 Mechanical property acceptance requirements for butt welding in plate (in welds that form part of the pressure hull boundary, and tensile loading under normal submarine operation) for applicable Material Class ~~(Special Applications)~~ 1 and 2.*

(b) When required by a specific project or specified testing regime, the surface crack extension from flawed bulge explosion (FBE) tests is to be not greater than 50 mm. ~~The presence and location of any laminar flaws are to be reported for special consideration.~~ Where indications of laminar flaws are detected within 10 mm of the tension surface, and they extend to within

50 mm of the fatigue cracked notch, then there is the potential for them to have influenced the shock loading of the bulge panel flaw. In such cases the FBE test is not considered valid.

(d) For welding procedure qualification tests, the mechanical properties for category C and D welds shall comply with the requirements stated in *Ch 12, 2 Welding procedure qualification tests for steels* except that Charpy impact test minimum energy requirements are to meet the requirements of *Table 12.7.1 Mechanical property acceptance requirements for butt welding in plate (in welds that form part of the pressure hull boundary, and tensile loading under normal submarine operation) for applicable Material Class ~~(~~Special Applications~~)~~ 1 and 2.*

**Table 12.7.1 Mechanical property acceptance requirements for butt welding in plate (in welds that form part of the pressure hull boundary, and tensile loading under normal submarine operation) for applicable Material Class ~~(~~Special Applications~~)~~ 1 and 2**

| Material Class (Special Application) | Tensile test | | Charpy V-notch impact tests | | |
|---|---|---|---|---|---|
| | Yield strength (~~MPa~~ $N/mm^2$) *See* Note 1 | Elongation (%) (minimum) | Test temperature (°C) | Average absorbed energy (J) (minimum) *See* Note 2 | ~~Average shear fracture (%)~~ Average Charpy impact crystallinity (%) (maximum) *See* Note 3 |
| High Strength Steel – Special Application 1 | >550 | ~~>18~~ 16 | −50 | ~~>~~50 | ~~>45~~ 55 |
| High Strength Steel – Special Application 2 (undermatched weld) | >565 | 16 | -50 | 50 | 55 |
| High Strength Steel – Special Application 2 (Matched weld) | >690 | 16 | -50 | 50 | 55 |
| Note 1. The individual reduction of area and tensile strength values together with weld metal chemical analysis are recorded for information only.<br>Note 2. No individual value may be less than 40 J.<br>Note 3. No individual value may be ~~less~~ greater than ~~30~~ 70 per cent. | | | | | |

## 7.2 LR accepted solutions for welding qualifications for high strength steel for special marine applications

7.2.5 The requirements presented herein represent an accepted solution for welding qualifications, certified for use High Strength Steel – Special Application 1 and 2, and the appropriate consumable grade for the relevant material class. ~~Q1(N) grade steel is an example of an acceptable material, and HSS1 is an example of an acceptable consumable grade.~~

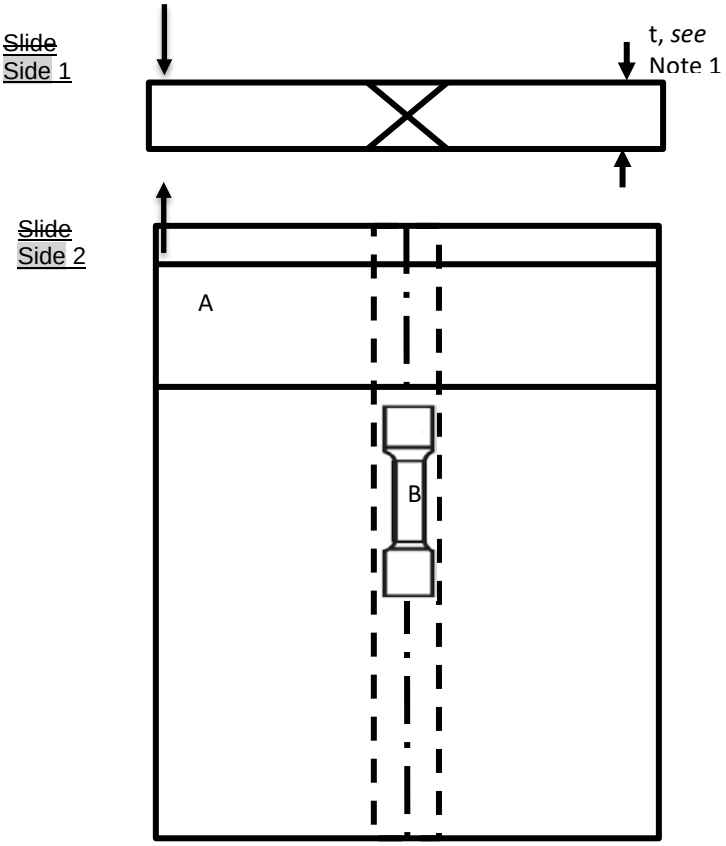
## 7.3 General requirements

7.3.3 Welding procedures for High Strength Steel – Special Application 2 may be approved with a weld metal strength lower than the minimum specified for the base material, i.e. undermatched welding. Where welding procedures are approved for undermatched welding, the requirements specified in *Ch 13, General requirements 10.3.5* are to be followed.

## 7.4 Welding procedure qualification tests

7.4.3 High Strength Steel – Special Application 2 butt weld applications are to be qualified via Category A and B routes. Fillet weld applications may be qualified via Category C and D routes.

*Existing paragraph 7.4.3 has been renumbered 7.4.4.*




Test requirements
A. Charpy, V-notch impact tests.
B. All weld metal tensile test (both sides)

Note 1. For thickness qualification range 20–100 mm, test piece thickness is to be 50 mm. Otherwise for thicknesses below 20 mm the test plate thickness is to be 20 mm. (If outside these thickness ranges, refer to the specific project requirements).

Note 2. The panel length is long enough to leave some archive material for retests. A shorter panel may be used if required.

Note 3. Side 1 is the first side of the test assembly to be welded and side 2 the second side.

*Existing paragraphs 7.4.4 to 7.4.7 have been renumbered 7.4.5 to 7.4.8.*

~~7.4.8~~ 7.4.9 The results of tensile and impact tests for test assembly A are to comply with the performance requirements of *Table 12.7.1 Mechanical property acceptance requirements for butt welding in plate (in welds that form part of the pressure hull boundary, and tensile loading under normal submarine operation) for applicable Material Class ~~(Special Applications)~~ 1 and 2.*

*Existing paragraphs 7.4.9 to 7.4.14 have been renumbered 7.4.10 to 7.4.15.*

*(Part only shown)*

~~7.4.15~~ 7.4.16 For category A and B welds, any change in the following will require a new test piece and requalification:

(d) **Parent material**: ~~Any change in plate thickness above or below 20 mm.~~

- Any change in parent material, except for the following permissible conditions:
  - It is permissible to use a welding procedure approved for welding High Strength Steel – Special Application 1 to weld High Strength Steel – Special Application 2, where High Strength Steel – Special Application 2 is to be welded with undermatching weld metal.
  - It is permissible to use a welding procedure approved for welding High Strength Steel – Special Application 2 using undermatching weld metal to weld High Strength Steel – Special Application 1.
- Any change from either matched to undermatched, or undermatched to matched welding, for High Strength Steel, Special Application 2.
- Any change in plate thickness above or below 20 mm.

### 7.5 Welding procedure specification (WPS)

7.5.1 A WPS for High Strength Steel – Special Application 2 which is approved for undermatched welding, shall specify the maximum root gap for which the WPS is applicable. This gap should be set prior to completion of the qualification test and in consultation with the project authority. The requirements specified in *Ch 13, General requirements 10.3.5* are to be followed, in addition if actual production welding root gaps are greater than as specified in the WPS, the project authority should be consulted.

*Existing sub-Section 7.5 has been renumbered 7.6.*

# Chapter 13
# Requirements for Welded Construction

## ■ *Section 10*
## Requirements for welded construction for high strength steel for special marine applications

### 10.1 Goal-based framework

10.1.6 The list of performance requirements (PR) is as follows:

(a) Welded constructions shall comply with the specified quality requirements and testing regime.

(b) Weld properties are to consistently meet the ~~following~~ requirements shown in *Table 13.10.1 Mechanical property acceptance requirements for consumable batch tests for consumable grade and applicable Material Class Special Application 1 and 2*, where batch testing is required by the project:

(i) ~~average absorbed energy from Charpy V-notch tests shall not be less than 50 J, with no individual value less than 40 J.~~

(ii) ~~average crystallinity shall not be less than 55 per cent, with no individual value greater than 70 per cent.~~

(iii) ~~the 0,2 per cent proof strength from the all-weld metal tensile test must exceed 550 MPa and the elongation must exceed 18 per cent. Reduction of area and tensile strength values are to be recorded for information only.~~

(iv) ~~the above requirements (i), (ii) and (iii) are to be demonstrated on both sides of the weld~~

**Table 13.10.1 Mechanical property acceptance requirements for consumable batch tests for consumable grade and applicable Material Class Special Application 1 and 2**

| Consumable grade | Material Class (Special Application) | Tensile test | | Charpy V-notch impact tests | | |
|---|---|---|---|---|---|---|
| | | Yield strength ($N/mm^2$) *See* Note 1 | Elongation (%) (minimum) | Test temperature (°C) | Average absorbed energy (J) (minimum) *See* Note 2 | Average Charpy impact crystallinity (%) (maximum) *See* Note 3 |
| HSS1 | High Strength Steel – Special Application 1 | >550 | 16 | −50 | 50 | 55 |
| HSS2 (Undermatched) | High Strength Steel – Special Application 2 (Undermatched welds) | >565 | 16 | -50 | 50 | 55 |
| HSS2 (Matched) | High Strength Steel – Special Application 2 (Matched welds) | >690 | 16 | -50 | 50 | 55 |
| Note 1. The individual reduction of area and tensile strength values together with weld metal chemical analysis are recorded for information only.<br>Note 2. No individual value may be less than 40 joules.<br>Note 3. No individual value may be greater than 70 per cent. | | | | | | |

### 10.2 LR accepted solutions for welded construction for high strength steel for special marine applications

10.2.5 The requirements presented herein represent an accepted solution for welded constructions High Strength Steel – Special ~~Application 1~~ Application 1 and 2, and the appropriate consumable grade for the relevant material class. ~~Q1(N) grade steel is an example of an acceptable material, and HSS1 is an example of an acceptable consumable grade.~~

## 10.3 General requirements

10.3.2 Welding and fabrication of High Strength Steel – Special ~~Application 1~~ Applications steel is to be in accordance with *Ch 13, 1 General welding requirements* and *Ch 13, 2 Specific requirements for ship hull structure and machinery* except where outlined below.

10.3.5 Where welding procedures for High Strength Steel – Special Application 2 are to be approved for undermatched welding, the design should take into account the minimum yield strength of the consumable in predicting the joint or structural properties. To ensure that design intent is maintained for any structure containing undermatched welds, the design should also account for any design tolerances, e.g. for weld misalignment, joint gap, repair of plate or weld defects. These limits are to be rigorously applied in production with any deviations or concessions being authorised by the project authority.

~~10.3.5~~ 10.3.6 Each batch of consumables require testing by the fabricator to demonstrate that tensile and Charpy V-notch impact properties of the weld metal meet the requirements of *Ch 13, 10.1 Goal-based framework 10.1.6.(b)*. The tests shall be carried out on a double-sided weld with a thickness representative of the intended production weld. The applicable parent material classes for batch testing the welding consumables are given in *Table 13.10.2 Welding consumable and parent metal combinations for batch testing for applicable Material Class Special Application 1 and 2.*

**Table 13.10.2 Welding consumable and parent metal combinations for batch testing for applicable Material Class Special Application 1 and 2**

| Consumables for Batch Testing | Allowable Material Class (Special Application) |
|---|---|
| HSS1 | Special Application 1 or 2 |
| HSS2 (Undermatched) | Special Application 1 or 2 |
| HSS2 (Matched) | Special Application 2 |

*Existing paragraph 10.3.6 has been renumbered 10.3.7.*

~~10.3.7~~ 10.3.8 ~~The application of pre-heat is required for all weld joints and is to be in accordance with the qualified welding procedure It is the responsibility of the fabricator and any project specific requirements to define low or high restraint. The following is recommended:~~

~~(a) For root runs a minimum pre-heat of 60°C is required for joints of low restraint and a minimum of 120°C for joints of high restraint.~~

~~(b) A minimum pre-heat of 70°C is required for all fill and cap runs.~~ The application of pre-heat is required for all weld joints and is to be in accordance with the qualified welding procedure, with consideration of the restraints of the intended application. The recommended pre-heat temperatures for each Material Class (Special application 1 and 2) are shown in *Table 13.10.3 Recommended pre-heat temperature requirements for applicable Material Class Special Applications 1 and 2.*

**Table 13.10.3 Recommended pre-heat temperature requirements for applicable Material Class Special Applications 1 and 2**

| Weld Type | Material thickness | Root Run (˚C minimum) | Filling Run (˚C minimum) |
|---|---|---|---|
| High strength steel – Special Application 1<br><br>High strength steel – Special Application 2 (undermatched welds) | All thicknesses | 120 | 70 |
| High strength steel – Special Application 2 (matched welds) | All thicknesses | 120 | 120 |

~~10.3.8 A higher heat input may be necessary for thicker weld joints.~~

10.3.14 For weld joints between High Strength Steel – Special Application 1 or 2, to other approved structural steels, the welding consumable is to be selected to match the strength of High Strength Steel – Special Application 1 or 2. ~~Consumables approved to grade HSS1 are an example of a matching consumable.~~

10.3.15 Welding conditions and techniques to be employed for production welding is to be in accordance with a welding procedure qualified specifically for joining High Strength Steel – Special Application 1 or 2 to the other approved structural ~~steel~~ steels.

10.3.17 Final NDE of weld joints is to be carried out 48 hours after welding for High Strength Steel – Special Application 1 and High Strength Steel – Special Application 2 undermatched welds. For High Strength Steel – Special Application 2 matched welds, final NDE of the weld joint is to be carried out 72 hours after welding.

*Existing paragraph 10.3.17 has been renumbered 10.3.18.*

~~10.3.18~~ 10.3.19 Weld repair to submersible craft intended for human occupancy already in service is to follow the requirements of ~~these Rules~~ this Section and *Ch 13, 6 Repair of existing ships by welding*.

# Chapter 14
# Plastics Materials and other Non-Metallic Materials

## ■ *Section 3*
## Testing procedures

### 3.9 Machinery chocking compounds

*(Part only shown)*

3.9.4 Creep is to be measured according to the following method:

(d) ~~The temperature and loading are to be maintained for a minimum of 100 days measuring the creep at intervals of 24 hours.~~ The temperature and loading are to be maintained for a minimum of 1000 hours (or until stabilised), measuring the creep at intervals of 24 hours.

3.9.5 Where a manufacturer requests a chocking resin to be reapproved and provided that there has been no change in formulation, the following properties are to be determined on samples of chocking resin that have been subject to the cure/post-cure conditions of the initial certification:

(a) Creep to be measured at specified loading as per initial approval over a period of 200 hours as per *Ch 14, 3.9 Machinery chocking compounds 3.9.4*.

(b) Peak exotherm temperature on cured/post-cured chocking resin.

(c) Barcol hardness.

(d) Temperature of deflection under load.

# Chapter 15
# Corrosion Prevention

## ■ *Section 2*
## Coatings

### 2.13 Ice Coatings

2.13.1 Low friction abrasion resistant surface coatings for use on the ice belt of Ice Class or Polar Class vessels may be recognised for this application by LR. *See* MQPS Book P - CHAPTER 8 PROCEDURE 19-8 - PROCEDURE FOR RECOGNITION OF ABRASION RESISTANT ICE COATINGS ~~Ice Class vessels using recognised coatings will receive a 1 mm reduction in the abrasion and corrosion allowance when calculating the required shell thickness in the ice belt.~~ Shell plate thickness reductions that may be applied (i.e. a reduction of the corrosion/abrasion additions, where effective protection is applied) are to comply with the following Rule requirements:

(a) for ships with Polar Class **(PC)** notation, *see Pt 8, Ch 2 Ice Operations – Ice Class, Table 2.10.7 Corrosion/abrasion additions for shell plating* of the *Rules and Regulations for the Classification of Ships.*

(b) for ships with Ice Class notation, *see Pt 8, Ch 2, 1 Strengthening requirements for navigation in ice – Application of requirements* of the *Rules and Regulations for the Classification of Ships.*

(c) for ships with Ice Class **1AS FS**, **1A FS**, **1B FS**, **1C FS**, and **1D** notation, *see Pt 8, Ch 2, 1 Strengthening requirements for navigation in ice – Application of requirements* of the *Rules and Regulations for the Classification of Ships*.

(d) for ships with Ice Class **1E** notation, *see Pt 8, Ch 2, 4.3 Shell plating* of the *Rules and Regulations for the Classification of Ships*.

(e) for naval ships with **1AS**, **1A**, **1B** and **1C** notation, *see Vol 3, Pt 1, Ch 1, 2 Hull strengthening requirements* of the *Rules and Regulations for the Classification of Naval Ships*.

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